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THE TOTAL SOLAR ECLIPSE OF FEBRUARY 3, 1916.

By C. D. Perrine.

The total solar eclipse of February 3, 1916, was observed at Tucacas, Venezuela, by an expedition from the Observatorio Nacional Argentino in charge of Third Astronomer Chaudet.

Owing to the general financial depression resulting from the great European war, it was not possible to send so well equipped an expedition as those which went to Brazil in 1912 and to Russia in 1914. This was unfortunate, particularly in the matter of the large-scale photographs of the corona. To have sent our 40-foot camera would have been to endanger the success of the entire expedition, and it was therefore with great reluctance that plans had to be made without it. Dependence for that part of the program had to be placed upon a camera of 11 feet focus attached to one of the polar axes.

It was also necessary to omit observations of the polarized light in the corona with the 11-foot cameras which were part of the equipment sent to Brazil and Russia.

The program of observations comprised the following:

A. Photographs of the corona with a camera of 11 feet focal length.

B. Photographs of the corona with a camera of 6 feet focal length.

C. Photographs of the flash spectrum and of the spectrum of the corona with an objective prism spectrograph of 5 inches aperture and 6 feet focal length.

D. A program similar to C with a prismatic camera of 27 inches focal length.

E. Photographic observation of the general spectrum of the corona with a slit spectrograph.

F. Photographic determinations of the total amount of light from the corona.

G. Visual determinations of the times of the contacts.

It was impossible to obtain some kinds of plates and films which in normal times are always to be had. This was a serious handicap chiefly to the spectroscopic and photometric work. No fresh orthochromatic or panchromatic plates could be found.

The expedition left Córdoba on December 2 and arrived in Tucacas on January 14 after many difficulties in obtaining transportation from Barbados to the Venezuelan coast.

The first week at Tucacas was rainy and unsuitable for the work of setting up the instruments, but by hard work Mr. Chaudet, without assistance except for a very little common labor, succeeded in getting all of the six instruments in condition for observing. These were mounted on two polar axes.

Efficient and willing assistance for making the observations was offered freely, and an able corps of observers was trained for a week before the eclipse.

The morning of the eclipse dawned rather unpropitious with heavy rain. Conditions improved, however, and by the time of totality the sky was covered only by thin haze. The haze interfered to some extent with the observations, chiefly those of the extensions and the general spectrum of the corona. It interfered much more seriously with the naked-eye view.

The entire program was carried thru as planned, and the plates developed on the four nights following. Twenty plates with twenty-eight exposures were obtained.

The focus of the 11-foot camera and of the large prismatic camera were excellent. There were some very small vibrations to the 11-foot camera, which disturbed the short exposures and the images of the prominences to some extent. They were not sufficient, however, to interfere greatly with the corona, especially the longer exposures.

The images with the 6-foot camera and the small prismatic camera are not sharp. Some of this is probably due to the diffusion by the clouds, but it is feared that some disturbance of focus of the 6-foot camera occurred, altho no such disturbance was noted after the eclipse, nor can any be accounted for. The focal image was examined visually shortly before totality and was then excellent.

The lack of sharpness is not sufficient to render these negatives entirely useless by any means, for the general features of the corona and the streamers are well enough shown for some purposes, as are also the prominences. In the small prismatic negatives the general forms of the images are easily distinguishable and many of the lines well enough separated and sufficiently sharp-edged for measurement.

The exposures with the large prismatic camera were all made on flat plates. The focus from the extreme red end ($\lambda 7300\pm$) to about H and K is good. Above H and K it is not sharp, altho many lines can undoubtedly be measured with some accuracy owing to the large scale.

Standard intensity squares were impressed on the long exposure of the 11-foot camera and the photometric plates before leaving Córdoba and these were then hermetically sealed in tin (as were all of the plates to be used on eclipse day). These were not opened in Tucacas until the day before the eclipse.[1]

The negatives of the corona with both cameras show streamers to an extension of one and one-half solar diameters.

The type of corona is intermediate between that at maximum and minimum of sun-spottedness, resembling that of 1898 more closely than any other recent one. Five groups of good-sized prominences are shown at the bases of the four principal wings of the corona.

A series of well-marked hoods is shown over the prominence in the southwest quadrant in the negatives taken with the 11-foot camera. One of the comparatively rare, long, straight, very slender and nearly radial streamers is shown by these negatives in the northeast quadrant.

This streamer is seen to be composed of two distinct branches near the limb.

The chromospheric layer appears to have been of considerable depth.

Exposures for the two flashes were obtained with both prismatic cameras, as well as exposures on the corona. Owing to their great light-gathering power, particularly of the larger instrument, three exposures were given in place of a single one during totality.

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[1] The plates which were standardized before leaving. Córdoba were somewhat mottled—due undoubtedly to having been exposed to the atmosphere two months before development.

No careful study of the plates has been made. A casual examination has not disclosed any features of special interest, however.

No trace of any gaseous radiations has been found in the corona proper.

These could hardly have been of any great strength or some of them would have been caught by the large prismatic camera, notwithstanding the unfavorable sky. The principal lines of the hydrogen series can be seen in the prominences in the exposures at mid-totality.

On the plate taken with the large instrument the spectrum is shown from λ3300 to λ7300. It extends some distance higher, but was cut off by the edge of the field. Bright lines are well shown to about λ5300. Below this the sensitiveness of the plate falls off considerably and at the extreme lower end only the D_3 and $H\alpha$ lines are shown. These are both strong and the forms of some prominences are easily visible in them. Continuous spectrum extends to λ7300 or below.

About 40 lines can be distinguished in the spectrum above λ3600.

Probably the greatest value these observations will have is in the heights of the different vapors above the solar surface, which can be determined from them for comparison with similar results at other eclipses.

The spectrum with the slit spectrograph is faint and does not extend beyond the extreme inner corona. It is strong enough, however, to be able to say with certainty that there are no dark lines. It is equally certain that any dark lines could not have been "burned out." The slit was placed east and west across the Sun's diameter.

The spectrum extends 3′ on the east from the Moon's limb and not over 1′ on the west.[2] It appears to be perfectly continuous on both sides without a trace of dark lines and with small bright points at H and K positions on the linear continuous spectrum on the west only.

This result is additional evidence in line with the explanation[3] found by the writer for the contradictory observations of the Fraunhofer spectrum, *viz:* that the inner corona is largely incandescent, whereas the outer corona shines chiefly by reflected photospheric light.

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[2] The exposure was stopped intentionally 20 seconds before the end of totality.

[3] *Lick Observatory Bulletin* **9**, page 61.

The evidence regarding the condition of the matter composing the corona, with the exception of the very small gaseous constituent, is now so strong, confirmed as it is by so many different methods of investigation, and so harmonious that it may be accepted with confidence. Briefly stated, it is that this matter is in the form of very small particles, either solid or liquid, or, what is most probable, both, and that within the region usually observed this matter is incandescent, the temperature being higher and the incandescence greater as we approach the solar surface.

The motions of the coronal matter and the causes of motion are not so well known, but it may be predicted that the greater part of these motions will be found to result from the explosive forces on the Sun's surface, gravitational action on the heavier particles and light-pressure on the lighter particles.

The photometric plates present some interesting results, chief of which appears to be that the prominences and chromospheric layer at the beginning of totality emitted more light than the corona proper. It may be possible to determine the total amount of light from some of the groups of prominences separately, as distinct rings can with some difficulty be traced on the negative taken near the end of totality.

The second and third contacts were well observed by Sr. Chaudet as follows:

1916, February 3, Tucacas mean time.

	Observed	Computed
Beginning of totality	$11^{h}\ 23^{m}\ 21^{s}$ A. M.	$11^{h}\ 23^{m}\ 21^{s}$ A. M.
End of totality	11 25 51 "	11 25 53 "
Duration	2 30	2 32

These agree very closely with the times obtained by the party from the Caracas Observatory. The computed times are given for comparison, the data being taken from the American Ephemeris and the correction of -10^{s} given by Ross in *Astronomical Journal* No. 681 having been applied. It will be seen that the beginning of totality agreed within the second and the end differed but 2^{s} from these predictions.

The position of Tucacas obtained by a commission from the Caracas Observatory is as follows:

Latitude	10° 47′.5	North
Longitude	68 19 .2	West of Greenwich

In conclusion, it is a great pleasure to testify to the aid received from the officials of the Venezuelan Government, both in Caracas and at Tucacas, and to the gentlemen who took part in the observations on eclipse day. Without this aid little of value could have been secured. As it is, a series of observations which is believed to be of considerable value was secured despite the interference from the unfavorable sky conditions. Just how valuable they are cannot, of course, be known until they have been closely studied. It is certain, however, that they contain definite information on several problems which will serve to aid in maintaining a nearly unbroken series of eclipse observations for half a century.

Detailed studies of the results when completed will be published in a special volume along with the very few of any value which were obtained at the eclipses of 1912 and 1914.

Observatorio Nacional Argentino,
Córdoba, June, 1916.